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ABSTRACT

The relationship between an individual's or community's awareness of natural hazards and subsequent behavior change is examined in this review of research. The document is presented in seven sections. Following Section I, the introduction, Section II discusses the role of experience in behavior change. Section III examines the role of education such as a flood hazard brochure, a hurricane awareness program, and public demand for earthquake information. Section IV investigates the effects of forced awareness such as flood plain zoning and California legislation which requires realtors to disclose the location of property within the seismic area. Section V discusses human rationality and decision making. The effects of community action on low priority issues such as water fluoridation, unrealistic optimism about the future, decisions on flood insurance, and personality factors are analyzed. Section VI explores alternative approaches to changing environmental behavior. Section VII concludes that awareness based on experience is associated with a greater tendency to adopt approved practices, although whether people can substitute information for experience is less certain. The public educational effort should include legislation, incentives which reinforce environmentally sound behavior, and community action programs. (KC)

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THE RELATION OF HAZARD AWARENESS TO ADOPTION OF APPROVED MITIGATION MEASURES

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I. Introduction

There is a common assumption in the literature and in public action on natural hazards that heightened awareness of hazards leads to greater likelihood of adoption of recommended mitigation measures. This may be seen typically in recurrent recommendations for educating the public. At the same time, there is an increasing skepticism that more information by itself will lead to appropriate adjustments. It has been documented over and over that planning to overcome the worst effects of natural hazards is most intense immediately after an extreme hazard event. This would suggest that heightened awareness due to experience leads to adoption of recommended mitigation measures. On the other hand, many observers of human response to hurricanes have noted that it is often people who have already experienced an event who seemed most reluctant to evacuate in response to hurricane warnings.[1] Dennis Mileti, Thomas Drabek and Eugene Haas, in a recent review of the social science literature on human response and adaptation to natural hazards and disasters, flatly stated that, "hazard perception has not been a powerful predictor of hazard adjustments being used."[2] Given the tendency to think of enhancing adoption of mitigation measures by means of public education, yet considerable doubt that this is an effective measure, it seems worthwhile at this time to examine more carefully the relationship between awareness and behavior. That is the aim of this paper.

Definitions. Awareness of knowledge of a hazard is roughly what is included in the term, perception, as used by hazards researchers.[3] The term would include attitudes, ideas, or feelings as well as the individual's understanding of the character and relevance of a hazard for self and/or community.[4] Part

of the difficulty of comparing results in the field to date is that this term may be defined differently by different authors so that only rough generalizations are possible. Here the net will be cast wide to draw in a great variety of conceptions which might help explain some of the discrepancies leading to such strong differences of opinion as are noted above. It will examine some of the most relevant work from studies of human response to natural hazards focusing mainly on a few sample studies, discuss some closely related work from the broader literature on natural resources and environmental issues, as well as briefly note more distant research which might by analogy have potential applications for future research on natural hazards. The aim will be to examine the evidence pro and con, with respect to the effect of awareness on behavior in order to make suggestions for future courses of action with respect to research and practice.

It is difficult to find a direct answer to the question "What behavioral difference does it make if a person has an inaccurate versus a more accurate perception of a particular hazard?" There is a wide theoretical range of responses by which individuals or communities can reduce the negative effects or increase the benefits of a hazard. Ian Burton, Robert Kates and Gilbert White state that:

> These may grade from immediate actions in the face of danger (such as warning systems, flood fighting with sandbags, or emergency evacuation) to long-term actions (such as planting crops less susceptible to drought or the construction of buildings designed to resist earthquakes). Other responses include the long-run adaptations of a culture to the extremes of its environment, as in building villages on levees.[5]

II. The Relationship Between Perception and Adoption

Very few hazard studies have directly explored the perception-adoption relationship and found anything conclusive. Mileti, et al., in their review,[6] mention only two such statements, a positive relationship by Saarinen for

drought between perception of hazard and adoption of adjustments,[7] and a conclusion by White for floods that a decision to adopt a particular adjustment varies with hazard perception.[8]

The Role of Experience. More definite evidence is found in examining the relationship between experience and behavior. If we assume that experience leads to greater awareness of the hazard then there is more evidence to support the proposition that hazard awareness may lead to behavioral changes. Mileti, et al. state: "There appears to be little doubt now that prior disaster experience is related in some manner to preparedness level. It has generally been found to be a positive realtionship."[9] People apparently do learn from experience with natural hazards.

Why then do we have the situation noted above where past hurricane experience provides no predicting power in terms of who is likely to evacuate? As in most human decisions there are multiple interacting reasons. First of all, extreme natural hazard events are rare and in many cases it is unlikely that individuals will have enough experience to make accurate generalizations. For example, in investigations following Hurricane Camille, which struck the Mississippi coast in August 1969, it was found that many people assessed their safety according to memories of an earlier smaller storm which struck in 1947.[10] This may have been a fatal mistake for many as most of those among the 123 dead were drowned while trying to ride out the storm in a residence near the waterfront.[11] Now it is expected that Hurricane Camille will serve as a new standard of severity in the area where it struck. This has been referred to as the process of anchoring and adjustment.[12] A natural starting point is used as a first approximation to the judgement, i.e., an anchor. The anchor is then adjusted to accommodate the implications of

additional information. People do learn from experience but they tend to believe they have a better picture of the truth than they really do especially in dealing with rare events.

The amount and type of experience are important factors in terms of behavior adopted. Kates found that where flooding was a recurrent phenomenon so that people were almost certain it would occur adjustments were likely to be adopted.[13] In the areas with greater uncertainty, the adoption of adjustments were also less certain. Clearly, it is important not only to determine whether people have experience with the hazard in question, but also the nature and frequency of that experience. The general tendency would seem to be to underestimate the threat of the hazard.[14]

The Case of Evacuation Before Hurricanes. In the case of Hurricane Camille, another interesting locational difference between the stayers and the leavers should be mentioned. Kenneth Wilkinson and Peggy Ross report that 89% of those who stayed were able to continue living in their homes after the storm which suggests that," . . . whether by luck or by shrewd calculation, most of the stayers among the respondents turned out to be in safe locations."[15] But they also add, "It is also quite possible that many of those in the sample who could not be located for interviewing were stayers whose homes were destroyed."[16] Stayers tended to be at higher elevations than leavers. Furthermore, although both groups tended to overestimate their elevations, the stayers tended to be more accurate in their estimates. Given their high survival rate in the face of the severe nature of Hurricane Camille, with winds of 200 m.p.h. and waves reaching 25 feet in height, it would seem most of the stayers could not be characterized as unaware nor as having made the wrong decisions by failing to evacuate.

Earl Baker and his associates in their study of the social impacts of Hurricane Eloise also found no pronounced differences in awareness between leavers and stayers, but did state: ". . . the single most powerful predictor of whether or not people evacuated their homes was the area in which they lived . . . people residing in the exposed beach area were significantly more likely to have evacuated (87% evacuated) than were people in the bay-bayou area (55% evacuated) or the inland regions (47% evacuated)."[17] There was at least a roughly accurate assessment of danger by the residents and a reasonable reaction in response to it. Since one of the two deaths resulting from Hurricane Eloise was because of an automobile accident, perhaps it was a good thing that more people did not evacuate. Evacuation is only one behavioral response to hurricanes and perhaps not the best test of the relationship between awareness and behavior because so many other factors affect the decision to evacuate and so many other types of mitigation behavior are possible.

Other reasons given for a failure to evacuate from Hurricane Camille and replicated later in a study of reactions to the storm threat of Hurricane Eloise were related to the warning system. For example some people listening to more distant radio stations did not receive as detailed a prediction of likely local impact as those listening to local stations, casual treatment by local stations in some cases led to confusion and doubt, many people did not grasp the crucial connection between tide and wind prediction; and although people knew a major storm was coming, few could comprehend its destructive force. Many had lived through previous lesser hurricanes and felt safe, others did not want to leave their property, some were influenced by others, a few had a sick person at home or other personal reasons for staying. Clearly, there were many interacting reasons why even well-informed people might display great differences in behavior.

The works discussed so far indicate that there is some support for the common sensical assertion that heightened awareness of hazards leads to greater likelihood of adoption of approved hazard mitigation measures. Such heightened awareness is likely to result from experience if sufficient experience has been gained. However, the very nature of extreme natural events makes it unlikely that most people in most places will have had sufficient experience to accurately estimate the magnitude of such events. The case of evacuation in the face of a hurricane was discussed to indicate that the expected relationship between awareness and behavior may not be forthcoming for methodological reasons. In psychological and sociological research on the relationship between attitudes and behavior the tendency has been to make very general measures of attitudes and relate this to specific behaviors.[18] If the link between the two is not direct, a poor correlation results because many situational factors intervene to obliterate signs of any connection. In the case of evacuation, there were clearly many situational factors which complicated the relationship including variations in warnings received and the more accurate perception of their height above sea level by the stayers, as well as a variety of personal reasons.

The Discrepancy Between Attitudes and Behavior. The first article which focused on the discrepancy between expressed attitudes and actual behavior dates back several decades.[19] Occasional and discontinuous discussions of this issue by psychologists and sociologists appeared in the next three decades. A thoughtful article by Irwin Deutscher in 1966 reviewed some of this work and suggested reasons why the empirical evidence and theoretical rationale remained largely ignored.[20] A few years later Allan Wicker concluded that there was little support in the literature for the postulated existence of stable underlying attitudes within the

individual which influence both verbal expression and actions.[21] Since then the debate has raged and recently several reviews on the issue have appeared which attempt to more accurately assess to what degree and in what ways attitudinal measures are related to other behaviors.[22] This debate on attitudes and behavior has now arrived in the field of geography and resource management.

In a recent article Timothy O'Riordan documented the discrepancy between environmental words and environmental deeds.[23] He sharply criticized the assumption of a causal connection between verbal expressions of attitude and actual behavior. The sense in which O'Riordan uses attitudes has some similarity with awareness as used here. He speaks of attitudes as "discrete bundles of closely connected beliefs and feelings that relate to various facets of an object or situation."[24] At the core of any attitude are dominant cognitions closely connected to a person's value system which are held strongly and cherished. Surrounding these are more peripheral cognitions less strongly connected to values which may be readily exchanged for other equally peripheral cognitions. Social scientists run the danger of picking up irrelevant cognitions and assuming that they will bear upon subsequent behavior. Such peripheral cognitions may be inconsistent with more relevant ones which affect behavior directly.

O'Riordan illustrated how this might work by some of his own research on water pollution views and detergent purchasing behavior of housewives in a small British Columbia community. He found many apparent inconsistencies between verbal attitudes toward water pollution expressed and buying behavior of housewives who purchased polluting phosphate detergents. Environmental attitudes were apparently peripheral in the detergent purchasing process which centered more on such factors as habit, cost, cleaning properties, etc.

It was possible to find a direct relationship between drought perception and adoption of adjustments, as noted above. One reason may be that in the case of the Great Plains wheat farmers awareness of the drought hazard is a central concern for their very livelihood depends on it. Their awareness was based on a comparison of actual droughts from weather information, and perceived drought years. The practice used to test the relationship between awareness and adoption was the dry farming technique of stubble mulch, the most highly recommended new practice in the area at the time.[25] In other natural hazards, such a relationship may be harder to detect for the perception of the hazard may be more peripheral to the respondents basic everyday concerns. Clearly if we wish to examine the relationship between attitudes and behavior or knowledge and behavior we must examine attitudes or knowledge which are directly relevant to the behavior being measured.[26]

III. Education and the Adoption of Mitigation Measures

Positive support for the proposition that education may lead to more adaptive behavior is provided by some recent studies which dealt directly with this issue as their major focus of research. These were among the very few which have evaluated specific public awareness programs.[27] In each case they raised as many questions as they resolved.

Flood Hazard Brochure. Marvin Waterstone sutdied the Denver Urban Drainage and Flood Control District's information brochure effect.[28] He evaluated the brochure's effect on heightening awareness of the potential flood hazard, its effects on motivating mitigation behavior, and made recommendations for modifying both the contents of the brochure and its distribution.

Telephone interviews were conducted with people in two different areas in one of which there was a divided sample. One group was interviewed prior to the distribution of the brochure, a second group one year after the brochures were mailed and a third 4-6 weeks after the brochures were mailed. In total some 250 people were interviewed. Several measures indicated that hazard awareness was significantly higher for the population which had received the brochure. Furthermore, other findings indicated that once awareness of the flood hazard had been created or heightened by the brochure, the residents may have begun to pay greater heed to other sources of flood information.

The brochure was also found to be effective in motivating residents to take protective actions to ameliorate the adverse consequences of flood events. Of those respondents who had taken some form of mitigation action such as purchase of flood insurance, flood-proofing their residence, or developing an emergency plan, a significantly higher percentage was found in the populations which had been mailed brochures than in the population which had not. In addition, the respondents in those populations had, on average, taken significantly more protective actions per person than in the population without brochures. The original hypothesis of the study that an important predictor of appropriate mitigation action would be hazard awareness was supported by the data.

Other findings of the Waterstone study led to a series of recommendations. While it was found that the brochures may be effective in heightening hazard awareness and motivating mitigation behavior the effects were apparently not permanent. Only four to six weeks after the brochure was disseminated the rate for remembering receiving it was 62%. Only 37% of a group interviewed about a year after the dissemination of information still remembered receiving

it. Many questions arise as to why certain people remember and others forget, whether it might be possible to heighten the memorability of the information, and what sort of sustained effort might be necessary to maintain a high level of awareness.

The content of the brochures was another variable found to be important by Waterstone. Even the people well enough motivated to attend public meetings surveying flood hazard information had trouble with certain features. For example, the scale of the map may have led to difficulties in identifying their homes and the instructions were not clear that the mailing list included only homes in the 100 year flood plain. Familiar referents should be provided to make more vivid the extent of former or maximum possible floods, and a comprehensive list of mitigation actions the individual can take. Other information on the brochure not directly pertinent could be eliminated to simplify the message.

Hurricane Awareness Program. Somewhat similar studies by Carleton Ruch along the Texas Gulf coast evaluated the influence of the Hurricane Awareness Program.[29] A questionnaire was mailed to randomly selected residents of 22 coastal cities of Texas. Preliminary results based on 363 residents showed that those exposed to the checklist/map brochures had significantly increased knowledge about hurricanes, that exposure to public service television presentations had significantly increased beliefs about the dangers of hurricanes, and that those exposed to radio public service presentations had no positive beneficial effects in increased knowledge. Since the formats of the information presentation by these different media varied considerably, from a vivid TV show to a casual radio commentary the relative effectiveness of the various media could not be conclusively established. Clearly both the type of

presentation and the media used do effect the response and both warrant further investigation. The question may be not which media is most effective but rather how to use each most effectively.

The Public Demand for Earthquake Information. One additional ongoing study with some bearing on public education for hazards is that on community response to earthquake threat in Southern California. Here there has been a great deal of publicity in recent years in conjunction with various earthquake predictions and forecasts. Much media attention has also been devoted to the Southern California Uplift or Palmdale Bulge which might be an earthquake precursor. Ralph Turner and his associates, in their investigation of public awareness asked some questions specifically focusing on public education.

An interim report presented by Barbara Young and Joanne Nigg[30] included preliminary data on these public education questions. In answer to an open ended question asking what the government should be doing, 29.9% of the respondents suggested public education on what individuals could do to prepare and what to expect during a quake. The only category of replies mentioned more frequently were suggestions for structural safety and building construction. To determine whether Southern Californians had been "saturated" with earthquake information after two years of relatively extensive media attention, respondents were asked their personal opinions on whether there had been too little, too much, or about the right amount of coverage on each of five types of earthquake information topics. From 65 to 83 percent of the respondents wanted more coverage on "Southern California Uplift and scientific earthquake predictions," "what to do when an earthquake strikes," "how to prepare for an earthquake," and "what government officials are doing

to prepare for an earthquake." Answers to several other questions indicated that the public wanted to receive information on earthquake predictions as well; "the more scientifically certain the prediction, the sooner people believe it should be announced. However, the data also seem to imply that scientists should not hesitate to issue preductions, even with a 50% probability of the event's occurrence, since the public is generally willing to accept announcements of moderate probability." All these findings indicate that there is no evidence to support the fear that a "saturated public will reject future earthquake prediction and safety news or features."

IV. Forced Awareness and Behavior Changes

Flood Plain Zoning. Another way to examine the links between awareness and behavior might be to examine situations where awareness was forced as in cases where public guidelines are developed to push behavior in a desired direction. This would be the case, for example, in flood plain zoning where guidelines imposed by the federal government are required at the local level. A study by Harold McPherson and Thomas Saarinen indicates that discussions related to flood plain zoning do not necessarily lead to a rise in the level of public awareness even among the people in the area affected.[31] More important, however, would be whether such a forced awareness (forced at the time of land use planning) would over time lead to a more rational pattern of land use in a community. An analysis by Leo Cheatham in Mississippi examined this question.[32]

Cheatham's study indicated that the compulsory federal program (National Flood Insurance Program) can change adjustments but that it has definite limitations. It may tend to divert the location of growth if the flood-prone area is not a growth pole. If, on the other hand, strong economic development factors are at work stimulating construction flood plain ordinances will

not necessarily reduce existing property values nor prevent increases in new construction on flood plain lands. This might suggest that compliance with regulations may be a low priority which is easily ignored if strong economic, or perhaps other, reasons exists. The Cheatham study did not, however, check to see whether flood protection had been built into the new construction to bring it up to the standards of flood insurance programs.[33] If in compliance with flood regulations construction in the flood plains could still reflect a positive change in behavior brought about by forced awareness based on flood plain ordinances.

Earthquake Awareness and Alquist-Priolo Legislation. If adjustments to natural hazards are perceived as low priorities this alone could account for a lack of positive adjustments even by persons well-informed about them. Different types of hazards might be expected to vary in terms of their problem priority rating although, in general, as rare and uncertain events, natural hazards might be expected to rank low. This seems to be the case for the earthquake hazard in California. Allen Wyner and Dean Mann for example, in a study of many California communities found that seismic safety is a low priority item on the public agenda.[34] Neither public officials nor influential private citizens typically see seismic safety as being very important in the day-to-day affairs of the community. Similarly in San Diego Saarinen and McPherson found that the earthquake hazard was not considered very serious nor did it rank high in a list of local problems.[35]

It may be that the low level of concern about earthquakes in California could change in certain areas as a result of the Alquist-Priolo legislation. This California act requires that realtors (or sellers, if the seller is not represented by a realtor) disclose to buyers the location of the property

within the seismic study are if it is so sited. Some studies completed at San Francisco University indicate changes in attitudes and behavior have occurred in one such "special study zone" on the San Andreas fault.

Raymond Sullivan, David Mustart, and Jon Galehouse conducted a series of surveys of residents along the San Andreas fault zone.[36] The objective of the survey was to evaluate the awareness of, and attitudes toward, earthquake hazards. The first survey was conducted in 1970 before the passage of the Alquist-Priolo Act, the last one, several years later, in 1976. Even in the latter year only 16% of those interviewed claimed they were informed of any possible earthquake hazards by the previous owner, developer, or landlord. However the percentage had doubled from the 8% who said so in 1970. Furthermore 55% (1976) as compared to 22% (1970) said they would inform future residents of potential earthquake hazards. This suggests that the recent legislation and attendant publicity may have had some effect on public awareness of these hazards. More significant than the change in attitudes was the increase in the percentage of residents who carried special earthquake insurance on their homes. This more than quadrupled from 5% in 1970 to 22% in 1976.

In spite of such favorable changes, and in spite of the fact that they were well aware of their proximity to the fault, residents were for the most part unconcerned about the potential destructiveness of a major or catastrophic earthquake. This attitude was attributed to the fact that the area has been subjected to only minor earthquakes over the past 70 years, and to a lack of experience among residents with other natural disasters. Other contributing factors suggested were the failure of many to recognize the direct relationship between faults and earthquakes, and the lack of knowledge of potential geologic hazards in the immediate vicinity of the fault zone.

V. Human Rationality and Decision-Making

Community Action on Complex Low Priority Issues. The difficulty of obtaining community action on a low priority item like natural hazards in which the risk interpretation may require some technical competence may be illustrated by the flouridation issue. Flouridation of drinking water to prevent tooth decay generally gains rapid acceptance by health professionals but is rarely adopted as a community decision if extensive debate takes place. A few vociferous opponents are enough to doom any referendum asking for its adoption. Robert Crain, Elihu Katz and Donald Rosenthal in their analysis of the flouridation issue explain that:

> "Its technical advantage is in dispute because of the gross claims made against it. Its importance in the eyes of the citizen and the city, is not great. It causes anxiety, particularly for people unable to juggle the pros and cons of a technical argument. It attracts both supporters and antagonists from essentially apolitical elements. There is not much political advantage to being for or against it, and yet the responsibility for the decision rests with the political leadership in the city."[37]

If the political leaders do not make the decision the voters are unlikely to do so. The threat of serious danger raised by the opposition is enough to frighten the voters into a negative vote. This type of thinking plus the tendency to forget quickly may account for the oft-repeated observation that adjustments to natural hazards tend to be concentrated in the period immediately following a crisis.

The Availability Bias. Paul Slovic, Sarah Lichtenstein, and Baruch Fischoff investigated how nuclear power is perceived relative to other beneficial and hazardous activities.[38] They found that nuclear power was

perceived to be in a class by itself in terms of public dread. More importantly they pointed out that this reaction is due to a fundamental cognitive mechanism that leads people to use imaginability and memorability as the basis for estimates of probability and frequency. This they called the availability heuristic.[39] Occurrences that more readily came to mind such as dramatic images of nuclear disasters, are judged to be more likely, and more frequent. In the face of this type of thought information designed to educate people about the safety of nuclear power may instead frighten them more. It matters little that most experts judge the risk to be grossly exaggerated for there are some experts who see it otherwise and they will be believed. In the face of technical ambiguity the public is likely to behave as they have on the fluoridation issues.

Support for the availability bias was provided by a study in which respondents were asked to judge the frequencies of 41 causes of death, including diseases, accidents, homicide, suicide and natural hazards.[40] The frequencies of accidents, homicide, cancer, botulism, and tornadoes, which tend to be dramatic, sensational events were found to be greatly overestimated. Furthermore, a later study showed that these biases in perception could be predicted moderately well both from the amount of coverage devoted to each cause of death in thelocal newspaper and from people's personal experience with these causes.[41]

In another article reviewing the literature on risk assessment Slovic, Fischhoff and Lichtenstein came to three general conclusions which have a bearing on the issue of education for behavior change.[42] A basic one is that people are resistant to change. Once initial impressions are formed they tend to structure and distort the interpretation of new evidence. Another is that making decisions about risky activities is difficult and humans may

not be intellectually equipped to respond to that difficulty constructively. Instead to avoid cognitive strain and emotional anxiety life's gambles are over-simplified to allow easy, if suboptimal solutions. A third general conclusion is that otherwise intelligent individuals do not always have accurate perceptions of the risks to which they are exposed. Hazards that are easy to imagine or recall, that are certain to produce death, that take multiple life, and have particularly dread consequences are overestimated while risks from common undramatic illness of one person at a time are underestimated. This is the availability bias noted above.

Unrealistic Optimism About the Future. A pair of intrigueing studies by Neil Weinstein investigated the tendency of people to be unrealistically optimistic about future life events.[43] In the first study he had 1258 college students compare their own chances of experiencing 42 events with the chances of their fellow students. Overall they noted their chances above average for positive events and below average for negative events.

The second study tested the idea that people are unrealistically optimistic because they focus on factors that improve their own chances of achieving desirable outcomes and fail to realize that others may have just as many factors in their favor. Weinstein suggested that perceived controllability of an event and commitment to achieve a particular outcome are necessary to produce unrealistic optimism and that this optimism is exaggerated by an egocentric bias. He explained that:

> "People appear to bring to mind their actions, plans, and personal characteristics that might effect the event. The factors recalled tend to make a desireable outcome more likely than if they took no action and had no useful attributes, so people give an optimistic response, it is as if they compare themselves to a hypothetical

person who does nothing to reach his or her goal or even one who engages in counterproductive activity."[44]

Decisions on Flood Insurance. Howard Kunreuther directed a large study on individual decision processes with respect to the purchase of flood and earthquake insurance. A major conclusion, based on over 3000 interviews from over 40 cities in the USA, and a set of laboratory experiements, was that "people refuse to attend to or worry about events whose probability is below some threshold, the level of which may vary from individual to individual and from situation to situation."[45] Individuals are reluctant to take the time to collect and to make the effort to process information on possible adjustments to natural hazards because they have more pressing things on their minds. Daily decisions take precedence. Low probability events are assigned a low priority. Thus they are not likely to be attended to in the press of other events.

Kunreuther found two factors which may be effective in raising the subjective probability level above the threshold required for action. The two most important factors in predicting insurance purchase deicsion were whether the hazard was considered to be a serious problem, and whether one knew someone who had purchased insurance. The first seems to be related to hazard experience. The second highlights the importance of the personal influence of friends or neighbors in the adoption process. The cost of the search for information is important and friends and neighbors are seen as convenient and reliable sources. The two factors are additive as well, for Kunreuther's results indicate that there was 55% difference in the probability of having insurance between those who knew someone with insurance coverage and thought the flood or earthquake hazard was a serious problem and the individuals who neither knew an insurance purchaser nor considered

the problem important.[46] The influence of personal contacts on the diffusion of hazard information through a population is one which deserves further attention.[47]

Personality as a Factor. Duane Baumann pretested a preliminary version of the Kunreuther questionnaire among 144 flood plain dwellers in New Braunfels and Seguin, Texas. In addition he administered Rotter's Internal-External locus of Control Test to the respondents. A paper, by him and John Sims, based on these data indicates that the personality dimension of locus-of-control (LOC) was one of three factors found to be significantly related to flood insurance adoption.[48] The others were previous experience of flood damage already noted above by Kunreuther, and social class which was positively associated with insurance purchase but considered to be relatively unimportant in the larger study.

Julian B. Rotter introduced the term, locus-of-control to represent the degree to which people accept personal responsibility for what happens to them.[49] Persons classified as internally controlled (internals) feel responsible for their own success or failures, believing that personal ability and action largely determine the outcome of events affecting their lives. Persons classified as externally controlled (externals) believe that their successes and failures are determined by forces beyond their control, by chance, luck, fate, or God.

Sims and Baumann had previously examined the effect of this personality dimension in a study which attempted to account for the fact that tornado death rates are higher in the southern United States than in the Midwest.[50] They administered a series of sentence completion items to respondents in Illinois and Alabama. Several of these items provided measures of locus-of-control. They found that respondents from Alabama had less confidence

in their ability to control their environments, were less trusting of the existing control systems, such as mass media warnings, and hence were less likely to adopt appropriate actions to cope with the threat of tornadoes. In this way Sims and Baumann indicated the possibility that personality might play a part in determining the disproportionately high tornado fatalities found in the South.

Support for the importance of this personality factor in effective coping behavior is not unanimous. Myra Schiff pointed out some weaknesses of the Sims and Baumann tornado study.[51] She found no relationship between locus-of-control measures and hazard adjustments in a study in London Ontario and noted several other studies using the study which produced negative or ambiguous results. On the other hand, a recent survey by Arthur Hadley, aimed at determining why so many people did not vote in national elections, found that the best predictors of voting and non-voting behavior were measures much like locus-of-control, i.e., whether one believed in luck or felt one could plan ahead, whether one felt politically efficacious or not.[52] Similarly, O'Riordan stated "There is now overwhelming evidence in the literature that expressions of environmental concern and the actions of radical reformers are linked to a strong sense of political competence."[53] Such people firmly believe that if necessary they are capable of changing the forces that affect their surroundings. Such findings suggest that more than distribution of information is necessary to improve adjustments to hazards. A better approach might be to make an "appeal based upon or cultivating an individual's sense of efficacy in coping with the hazards" as has been suggested by White.[54]

The past several sections of this paper have shifted somewhat from the earlier evidence supporting the common sense notion that more information

should lead to better adjustments. Although, once more, experience is seen as a fine teacher suggesting a certain rationality in humans, much new evidence has been presented which indicates that there are definitely limits to human rationality. There is little value in feeding people more and more information if their habit patterns, or personality, or information processing capabilities make it unlikely that they will assimilate it. The information may have to be tailored to people's personality dimensions, or to raising the subjective probability level of the hazard and hence its priority level, or to fit the normal flow of information through a community. Furthermore, it is clear that more is needed than information. To minimize losses due to hazards will probably require further federal actions such as flood plain zoning and mandatory flood insurance since adjustments to hazards are low priorities for individuals and small localities. There is little political advantage to be gained by local politicians in pursuing wise hazard management policies and the uncertainties involved make it unlikely that individuals will act on their own. Some prodding by laws, encouragement by incentives or positive examples, and direct action programs may be necessary to bring about the desired adoptions.

VI. Other Approaches to the Problem

Applied Behavioral Analysis. Pertinent to the problem of changing environmental behavior is a new line of research known as applied behavioral analysis.[55] This research has focused more on how to solve environmental problems than on peoples' reactions or response to problems. In part this approach has developed as a reaction to the problem noted above, that increased awareness does not necessarily lead to behavior which solves environmental problems. Rather than concerning themselves with increasing the level of awareness alone these experiments have tried to induce

environmental change through the manipulation of human behavior. So far the experiments have focused on such environmental problems as littering, noise recycling, changing the use of transportation systems, and changing patterns and levels of energy use. That have moved from small scale time-limited projects to large-scale programs.

Applied behavior analysis is based on Skinnerian principles. A typical approach, the withdrawal format, would involve measuring baseline behavior then introducing an experimental manipulation and recording and changes in behavior. The independent variable would then be withdrawn to recreate baseline conditions and determine whether behavior returns to the baseline level. In littering experiments, for example, the effects of provision of trash cans, signs, or litter bags can be measured in terms of reduction in ground litter. Rewards for turning in litter were also tested using such devices as direct monetary payoffs or lottery chances provided in exchange for bags of trash. Some applied behavior-analytic solutions have been developed which show some promise for implementation on a large scale with substantial reductions of litter at reasonable cost.

In research on energy-consumption behavior analytic research has led to several conclusions. First is that energy consumption is at least in part a behavioral problem. Second, information alone is probably not important even though this is the program most favored by government and power companies. Feedback, beyond just lower power bills, appears to produce reductions in energy consumption. Monetary payments are very effective whether in combination with other procedures or alone. Such payments work even when quite small.

Should the intervention strategies of these psychologists develop into inexpensive, relatively automatic forms they could be useful as part of the

package of incentives leading to behavioral change. Many reinforcement programs currently require the active participation of someone to observe and reinforce appropriate behavior. However, programs could be devised that produce automatic consequences. In the energy problem these might include pricing policies, billing procedures, and automated feedback. These, to be effective, might also require political, legislative or economic actions beyond the scope of the psychologists.

Public Service Advertising. People interested in educating the public about natural hazards might do well to examine the work of communications researchers on public service advertising. A public service announcement is defined as "an announcement for which no charge is made and which promotes programs, activities, or services of federal, state, or local governments on the program activities or services of nonprofit organizations and other announcements regarded as serving community interests, excluding time signals, routine weather announcements, and promotional announcements."[56]

The same assumption previously mentioned as characteristic of hazards education has been noted in other areas as well, namely, that if only people were exposed to the right information, they would subsequently make rational choices. There has often been the further hope that once released to the public this information will spread and prevent unwanted consequences. Such reasoning has motivated the majority of public prevention or intervention campaigns. But relatively few information campaigns have been evaluated and in the rare instances when this has been done the results have been discouraging.[57] This appears to be true for drug education[58] and for prevention of alcohol problems.[59] As Gerhard Hanneman stated in testimony prepared for the United States Senate subcommittee on Health and Scientific

Research, "the evidence is almost overwhelming that public service advertising, unless it is highly controlled, is totally ineffective in influencing attitudes and behaviors."[60]

Hanneman went on to state that well conceived public advertising can be highly effective. Several factors he listed which would maximize the effectiveness of public health communications could no doubt be applied in efforts to enhance the adoption of mitigation measures for natural hazards. For example, media time should be purchased and the campaign should endure over time, immediately applicable information should be provided to individuals, careful audience targeting is essential, TV is the most cost effective medium in reaching the information needy, and message content should be oriented to topics that can be used in social communications by the audience.

Some recent statements by groups concerned with public education for various purposes suggest that there is a growing awareness that more evaluation is necessary for future educational campaigns. Criticism of current programs, like that in research on natural hazards, focus on the narrow range of alternatives given support, the need for flexible multipronged programs,[61] the need for the application of more social-psychological theory,[62] and the need for direct community action such as discussion groups, interpersonal communication and community involvement.[63]

Communications Research. Many of the elements required for an educational campaign designed to bring about beneficial behavioral changes are embodied in an ambitious interdisciplinary experiment conducted in California to unsell heart disease. Nathan Maccoby, in communications research, and John Fahrquhar, a professor of medicine, describe the theory behind the experiment as quite simple.[64] it involves teaching people to behave in ways different from their present lifestyles. By selective rewarding of

behavior people are taught to stop smoking and to adopt more healthful diets, exercise, and tension patterns. By these means, the reduction of the risk of coronary heart disease should be accomplished.

Three similar small towns were selected for a community level study, Watsonville and Gilroy as experimental communities and Tracy as a control town. Interviews and physical examinations were conducted with samples of residents from each town. After the initial survey a carefully designed and pretested eight-month media campaign in both English and Spanish was conducted in Watsonville and Gilroy. This involved considerable use of TV, radio, and local newspapers as well as a direct mailing of printed items. Additional messages were conveyed by business cards and billboards. To determine how far short such a communication effort would fall from a more ideal one a sample of high-risk people in Watsonville was provided with personal instruction employing behavior modification and other learning methods. Intensive instruction in groups of 15 included analysis of existing relevant behavior, modeling of new acts by the instructor or model, guided practice of new behavior, reinforcement of new behavior, and finally maintenance of new behavior without the instruction.

Some preliminary results presented by Maccoby and Farquhar indicate that after one year people in the two towns subjected to media programming and other forms of persuasion changed more than the people in the control town. Furthermore, people in the high risk groups who recieved intensive instruction changed considerably more than people who were only exposed to general mass-media information. There were positive changes not only in information about risk factors and attitudes but, more importantly, in medical data as well.

Further follow-up studies show evidence of positive risk reduction effects for both the media and media plus face-to-face instruction treatments after two years compared to the control group.[65] At the end of the second year, the level of estimated coronary disease risk decreased by 17-18% in treatment community samples whereas it increased in the control community by more than 6%.[66] Interestingly, by the end of the second year the apparent difference between the effects of media and media plus face-to-face instruction on overall risk was diminished and no longer statistically significant. The media plus intensive instruction created changes more quickly, but similar reductions were achieved through mass media alone after an additional year. The changes in knowledge, behavior and risk observed at the end of the first year were maintained and even improved in the second year. This indicates that mass media community education campaigns can contribute to behavioral change in a community setting.

VII. Conclusions

The assumption that public education on natural hazards will lead to greater awareness which in turn will lead to the adoption of recommended mitigation measures is probably widely held because it contains a certain element of truth. Awareness based on experience clearly is associated with a greater tendency to adopt approved practices. Whether people can substitute information for experience and learn from the experience of others is less certain.

The doubts that awareness leads directly to predicted behavior also rest on good grounds. The attitude-behavior research in psychology and sociology indicates that the strength of the relationship depends to some extent on how the attitudes are measured and how directly they link to the behavior, as well as the many situational factors which impinge on the items

of behavior measured. Similarly, in natural hazards research awareness may not lead directly to the desired behavior for a variety of personal and situational factors as well as some basic aspects of human decision-making in the face of low probability events.

Public education on natural hazards is necessary. The public apparently wishes to receive information on hazards affecting them. In some cases it is absolutely essential, as in the Big Thompson Canyon where people perished because individuals and officials simply did not know what to do when a flash flood occurred in that narrow canyon.[67] It is also apparent from the limited research conducted to date that distribution of brochures to hazard zone residents can help to increase awareness and lead to better adjustments. It is still not clear how stable or long lasting such adjustments might be or what circumstances might lead to similar results in other places. Many questions remain as to why certain people remember and others forget, or how to heighten the memorability of the information, or how to maintain a high level of awareness if it is achieved. Similarly, a host of questions remain to be answered in terms of the most effective format for presentation of information in each medium of communication including sequence, timing and duration of presentation.

If humans were completely rational we might expect that their decisions with respect to hazard mitigation measures would coincide more closely with the recommendations of the experts. But humans do not always behave rationally. Although research has clearly established that people can and do learn from hazard experience the rareness of major hazard events in any one place makes it unlikely that most will ever gain from experience a true appreciation of their potential magnitude. Evidence from hazard research and studies on human judgment and decision-making indicates that people tend to think they

know more than they really do and are very resistant to changing habitual patterns. The availability bias, that is the tendency to estimate the frequency and magnitude of events by the ease with which they can be recalled or imagined leads to errors in judgment. In addition there is some doubt that humans are intellectually equipped to deal effectively with the real difficulty of making decisions about risky events. This is illustrated by the tendency to oversimplify life's gambles to allow simple but suboptimal solutions.

Even if human judgment were better, awareness of natural hazards would not necessarily lead to optimal decisions for the low probability of extreme events leads people to ignore them. Since natural hazards are rare in any one place they fall far down on people's lists of priorities and may never get attended to by individuals of small localities. Except immediately after a disaster, it is hard to arouse enough enthusiasm to take action on mitigation measures. Given public apathy no local politicians are likely to provide leadership in this direction.

For an effective educational program random distribution of information on hazards to the public is not enough. The educational effort should be part of a broader set of strategies whose elements should evolve over time as a product of research and experimentation. These could include laws such as flood plain zoning regulations which prod people in the direction of better land use planning or incentives which reinforce environmentally sound behavior such as those being sought in applied behavioral research. The importance of personal influence from friends and neighbors and the need for feedback and encouragement suggest that community action programs involving face-to-face contact in meetings and small groups may be necessary for optimal results.

The effectiveness of any public education campaign will depend on the manner in which it is conducted. Examples of successful campaigns from public service advertising and communications research should help provide guidelines for those engaged in increasing public awareness and influencing behavior with respect to natural hazards. Thoughtful selection of the target audience is a basic first step for the strategies could differ for hazard zone occupants, the general public, or influentials in the communication network of an area. The message to be imparted should be based on the adjustments more desirable for the particular public. Rather than broad generalities about the hazard in question, the focus should be on highly specific actions the audience can take, clearly presented in terms of familiar referents, such as flood heights marked on local landmarks. The medium for the distribution of the message is another important decision. Since TV captures the attention of the largest proportion of the public it might be most appropriate for the broadest public appeals. Whatever the medium, brochures, billboards, newspapers, radio, or TV, much care must be taken in presenting the message. This might involve concern with vivid detail and memorability of the image presented to attempt to raise the subjective probability threshold, or personality appeals designed to raise the sense of personal efficacy and thus encourage coping action.

A limiting factor will likely be the budget so it is important to think in terms of how to apply most fruitfully the resources available. Although we are at an early stage in research on public education designed to change behavior with respect to natural hazards enough is know to indicate that such change is possible. If care is taken in designing the campaigns, and an experimental approach adopted, so that lessons are learned

from experience, it seems likely that future efforts in public education on natural hazards could contribute substantially to a reduction in the toll of deaths and damages from future hazard events.

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